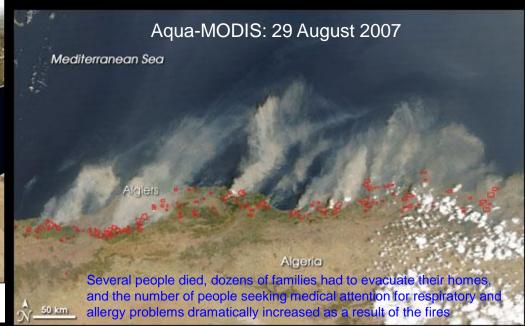


Aerosol index

August 27

low

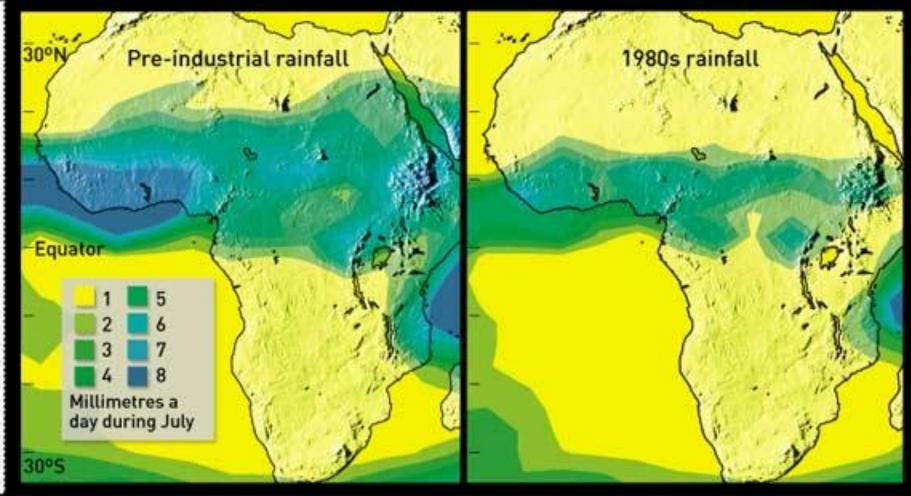




hel dries out

African Droughts

(New Scientist: 19:00 12 June 2002)

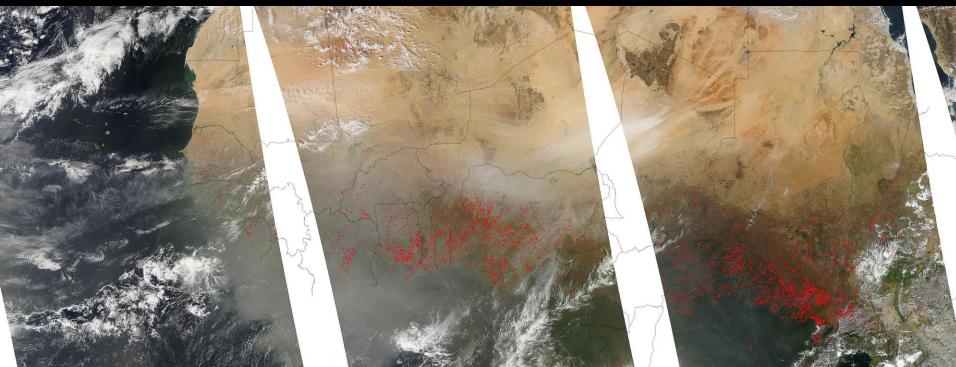


"Although the droughts have had climate experts scratching their heads, the impacts have been obvious. During the worst years, between 1972 and 1975, and 1984 and 1985, up to a million people starved to death."

Biomass Burning And The Water Cycle In Northern Sub-Saharan Africa

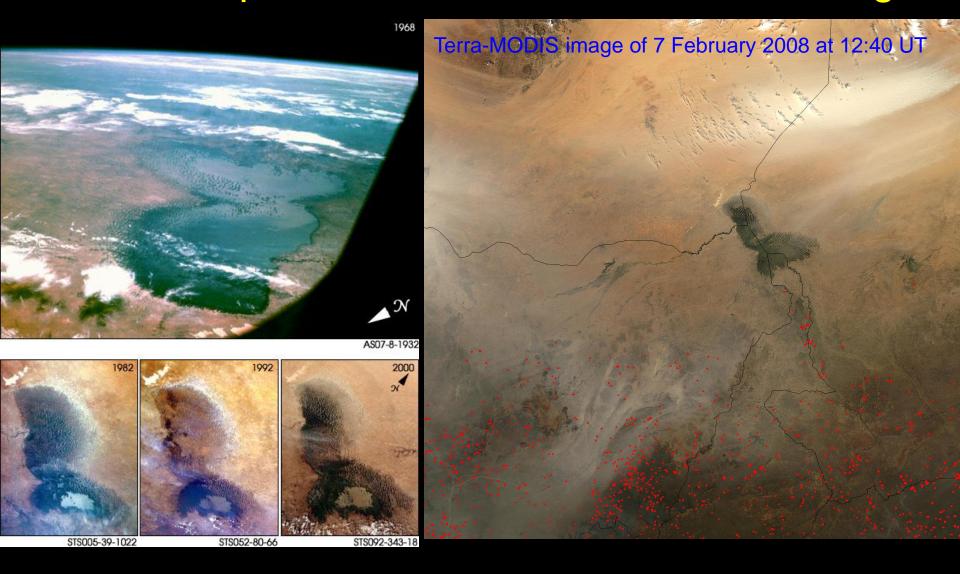
Charles Ichoku¹, Jimmy Adegoke², Charles Gatebe^{1,3}, Jejung Lee², Jun Wang⁴, Eric Wilcox⁵, John Bolten¹, Fritz Policelli¹, Shahid Habib¹, Rakiya Babamaaji², Churchill Okonkwo⁶, Luke Ellison^{1,7}, Rajesh Poudyal^{1,7}, Sajith Vezhapparambu⁸, François Engelbrecht⁸, Zhifeng Yang⁴

- 1. NASA Goddard Space Flight Center, Greenbelt, MD
- 2. University of Missouri, Kansas City, MO
- 3. Universities Space Research Assoc, Boulder, CO4. University of Nebraska, Lincoln, NE
- 5. Desert Research Institute, Reno, NV
- 6. Howard University, Washington, DC
- 7. Science Systems & Applications, Inc., Lanham, MD
- 8. CSIR, Pretoria, South Africa



Aqua-MODIS image of January 17, 2007 (NASA EarthObservatory)

Lake Chad: poster child of African Sahel Droughts



Fires -> Bare Soil -> Dust -> Desertification

Republic of Ghana



Forest Reserves Under Pressure in Ghana



In the 1973 image the vegetation inside and outside the protected areas appears green and robust

In the 2002/2003 dramatic change is apparent; some of the northern reserves have been decimated and the northern edge of the forest zone has moved south



AFRICA: Atlas of our Changing Environment

Biomass-burning and water-cycle dynamics dilemma

```
Biomass Burning => Oct - Mar
Water cycle => Apr - Sep
```

Framing the Science Questions:

➤ Biomass burning => land-cover and ecosystem changes,

=> albedo change,

=> smoke and dust emissions,

=> atmospheric heating rates.

Surface changes => surface runoff and infiltration

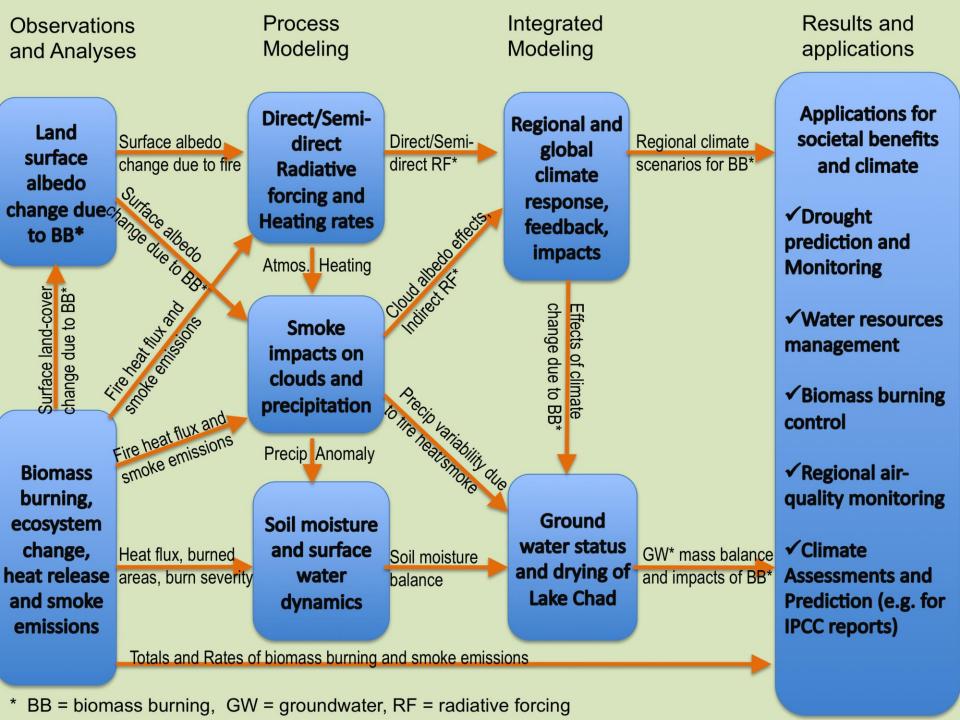
=> soil moisture content and retention

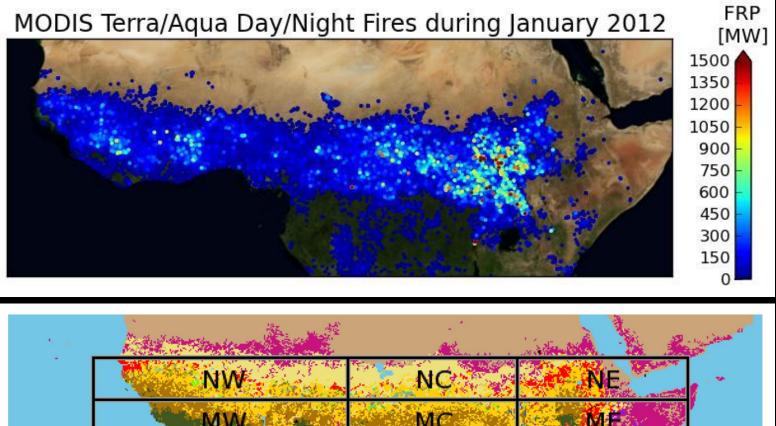
Atmospheric changes => rainfall variability

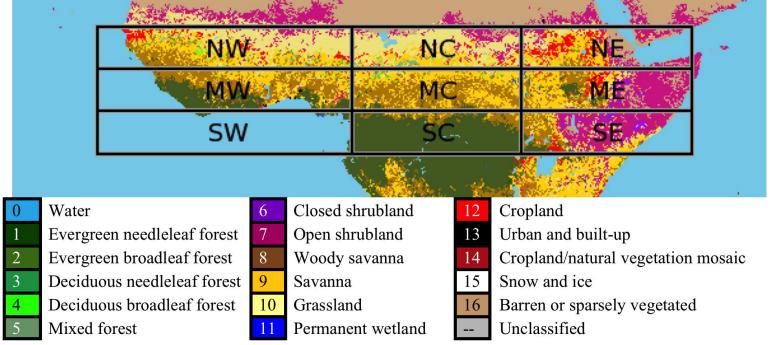
Rainfall variability => Surface and Ground-water hydrology

=> Surface changes and Biomass burning

- Climate variability and trend?
- ➤ Lake Chad basin?
- Societal Benefits.

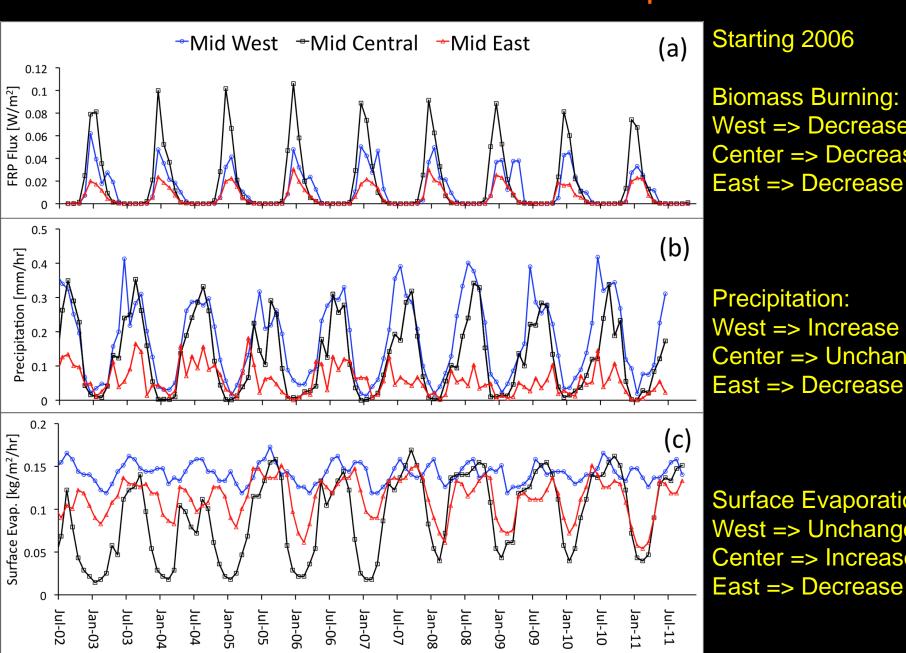






MODIS landcover map based on IGBP landcover classification.

Covariance between BB and WC parameters

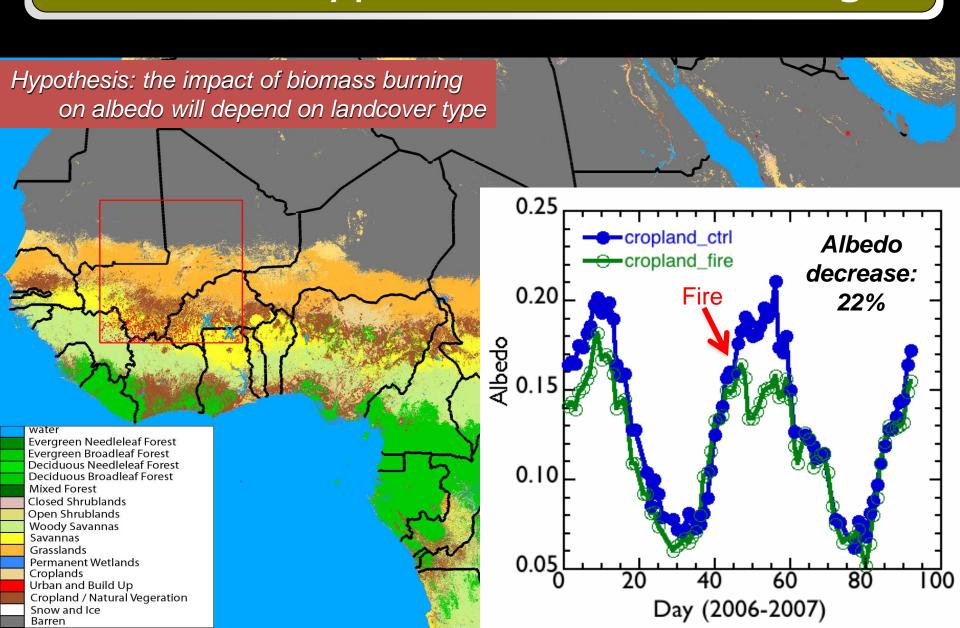


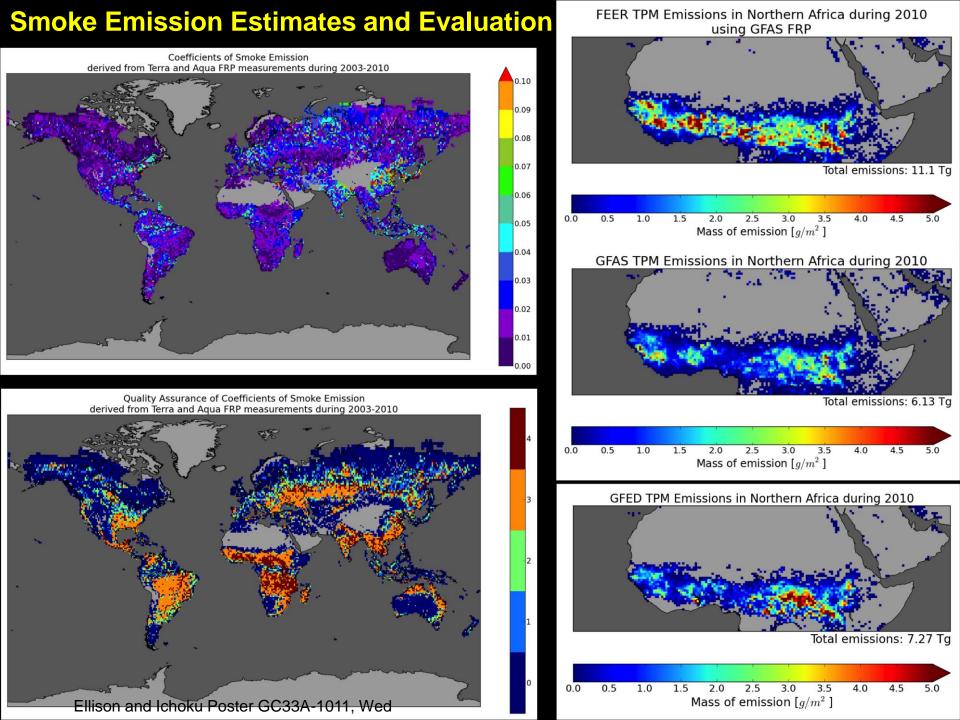
Biomass Burning: West => Decrease Center => Decrease

West => Increase Center => Unchanged East => Decrease

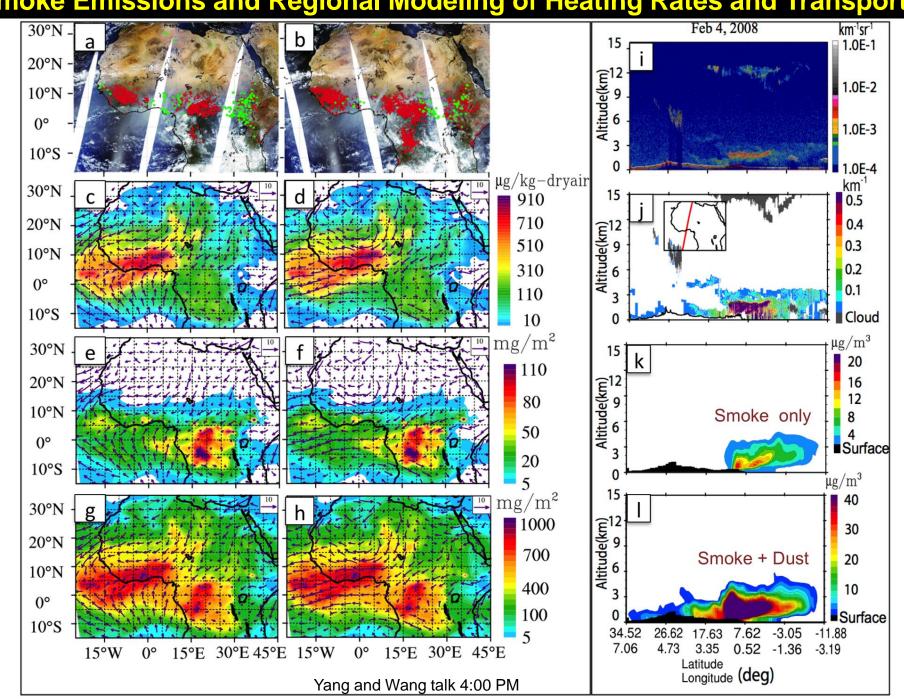
Surface Evaporation: West => Unchanged Center => Increase East => Decrease

Landcover type and Albedo Change

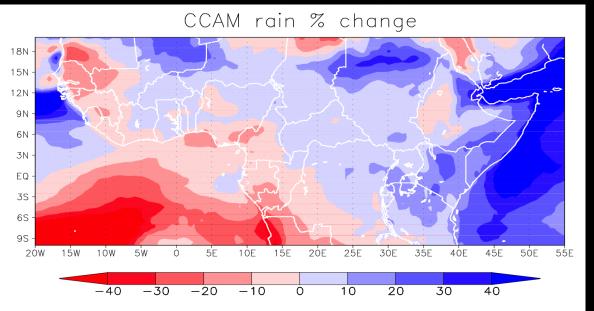




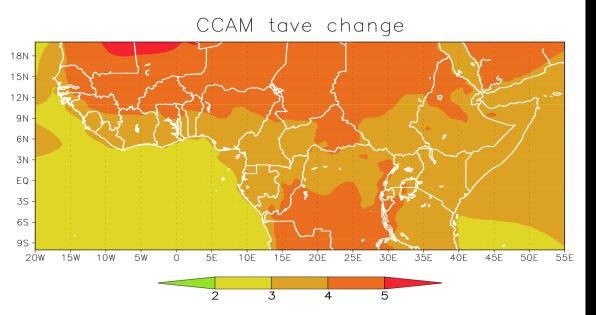
Smoke Emissions and Regional Modeling of Heating Rates and Transport



CCAM Regional Climate Change Projection for 2071-2100 relative to 1961-1990

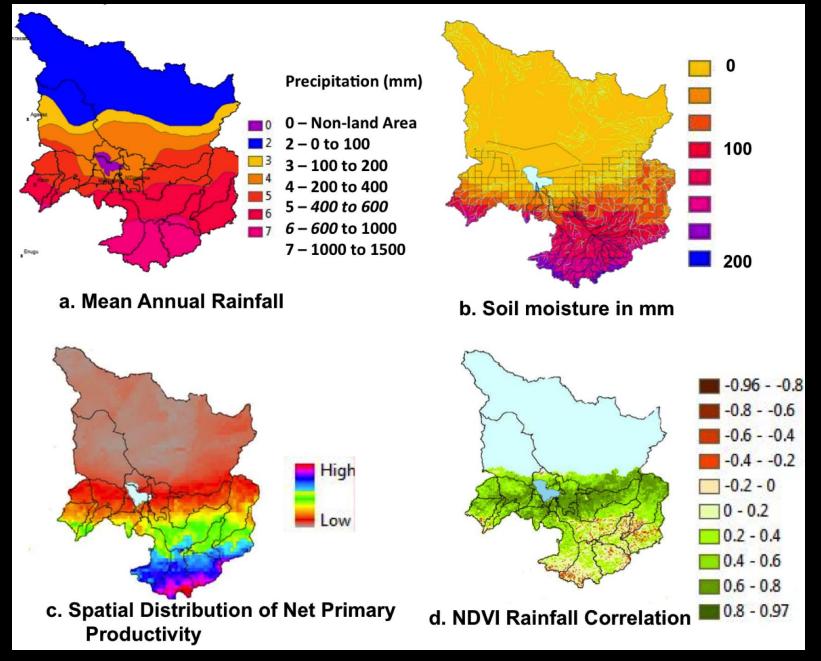


Precipitation projected to increase, except along the west coast

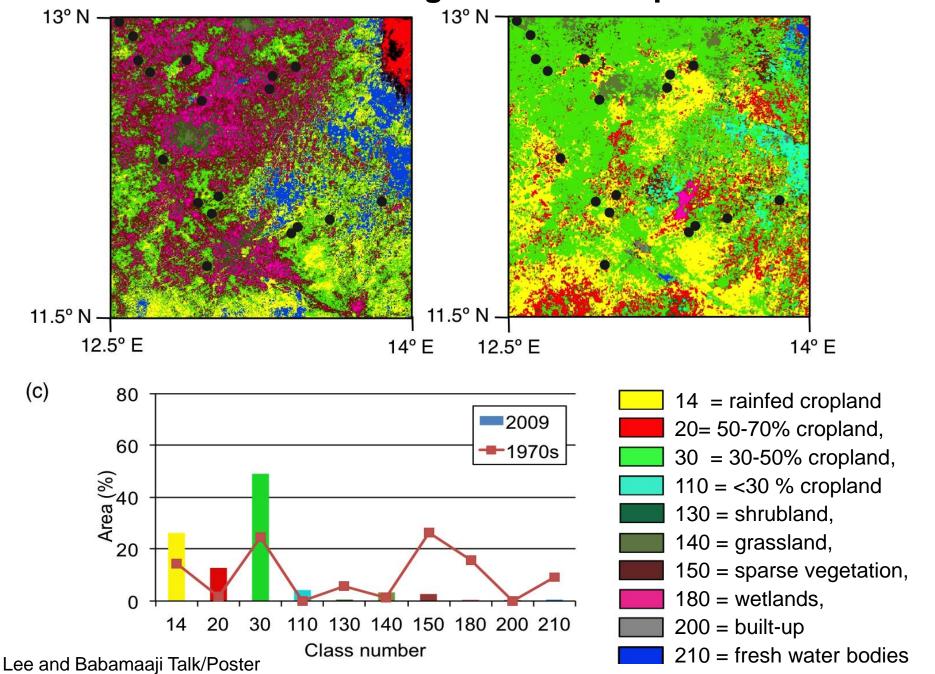


Temperature projected to increase by 3–5 deg.

Rainfall/Vegetation Correlation reveals Anomaly due to Biomass Burning



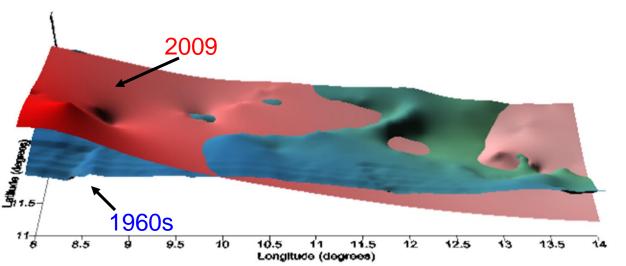
Lake Chad Landcover Change in 2009 compared to the 1970s



Groundwater Field Survey in the summer of 2009









Preliminary Findings

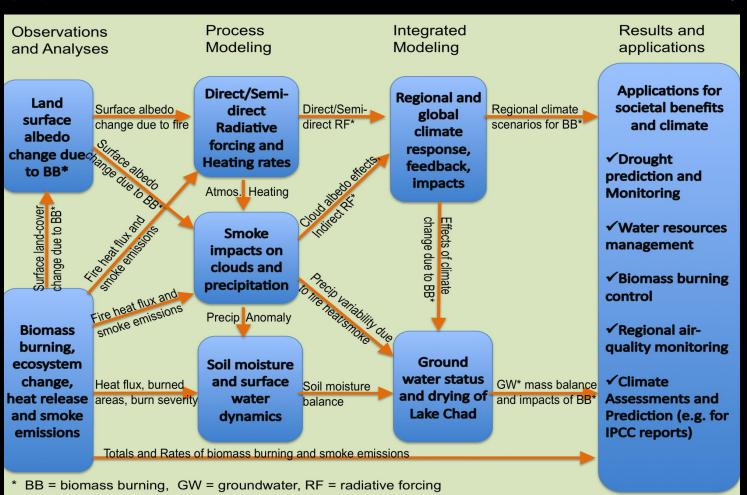
➤ Time Series Analysis of Regionally Aggregated Monthly Mean Satellite Measurements Shows That Starting in 2006:

	West	Central	East
Fire activity	Decrease	Decrease	Decrease
Precipitation	Increase	Unchanged	Decrease
Surface Evap.	Unchanged	Increase	Decrease

- There is a net decrease in surface albedo due to BB.
- Smoke emission is significant (25% global) and mixes with dust.
- Climate projections show increase in Temp and Precip by 2100.
- >Landcover around Lake Chad changed from wetland to cropland.
- Groundwater increased west of Lake Chad.

Next Steps

- (i) consolidation of analysis and modeling efforts
- (ii) integration of various research components
- (iii) field validation and collaboration
- (iv) share results with end-users and the community



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NASA Earth Science Interdisciplinary Studies (IDS) (c/o Jack Kaye, Hal Maring) for Funding Support

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Nigerian Agencies/Universities for Field Logistic Support